Applications of Functionalized Natural and Synthetic Macromolecules

Prestel by

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Aim of the work

Every large molecule (as of a protein, nucleic acid) built up from .smaller chemical structures called macromolecules

And it's very important because it has immune response in which the .drug binds to macromolecules on the surface

.Divided into two groups nature and synthetic

.Their importance increases further with chemical modifications

.We can modify them because they have active fanction groups

Biodegradable Polymers Classifications and Challenges

Depending on the source of origin, biodegradable polymers can be classified as either derived naturally through fermentation or by extracted .biomass through polymerization

Various categories of biodegradable polymers derived from agricultural sources such as polysaccharides or protein which are usually extracted .from micro-organisms

.Polysaccharides that includes cellulose,chitosan,starc

Chitosan Derivatives and Their Application

Chitosan is a renewable natural alkaline polysaccharide that has no .toxicity and no side effects

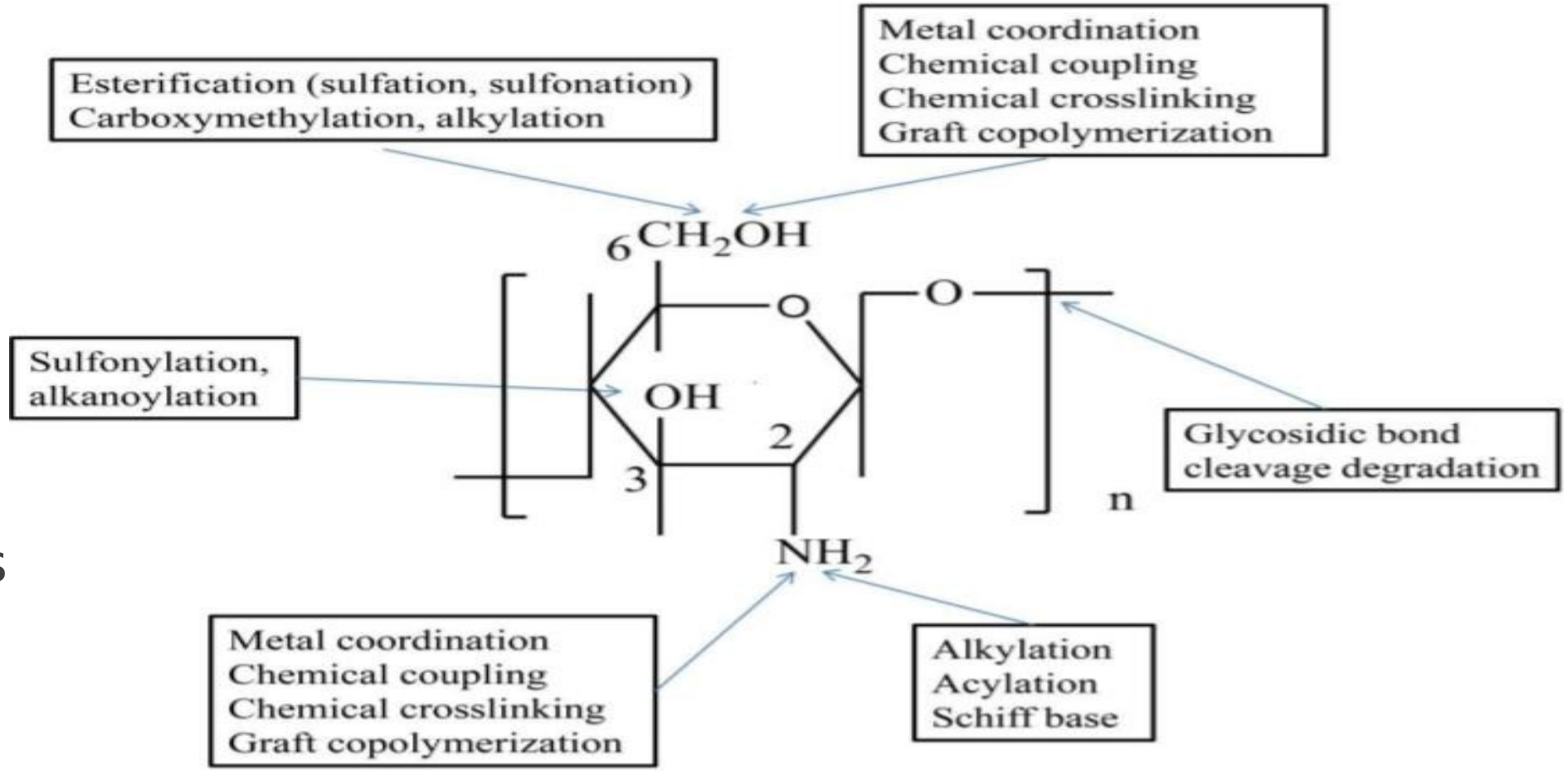
Both, chitin and chitosan are employed in countless applications as adsorbents for the removal of dyes and metal ions in waste water treatment, Lotions and body creams in cosmetics, vehicle for drug .delivery

Chitosan is widely used in packaging applications due to its .biodegradability, non-toxicity

however due to chitosan has hydrophilic nature it's show lower stability

Modification of Chitosan

The chemical modification of chitosan can improve its physical and chemical properties, as well as expand its .applications



Acylated Modified Chitosan

.Acylation modification is the most common modification of chitosan

introducing aliphatic or aromatic acyl groups to the Molecular chain.

Moreover, N-acylated chitosan derivatives don’t cause an inflammatory reaction in the human body, so N-acylated chitosan can be used in Pharmaceutical .applications

Nacylated chitosan, with high solubility, can be used as a carrier for .Hydrophobic drugs

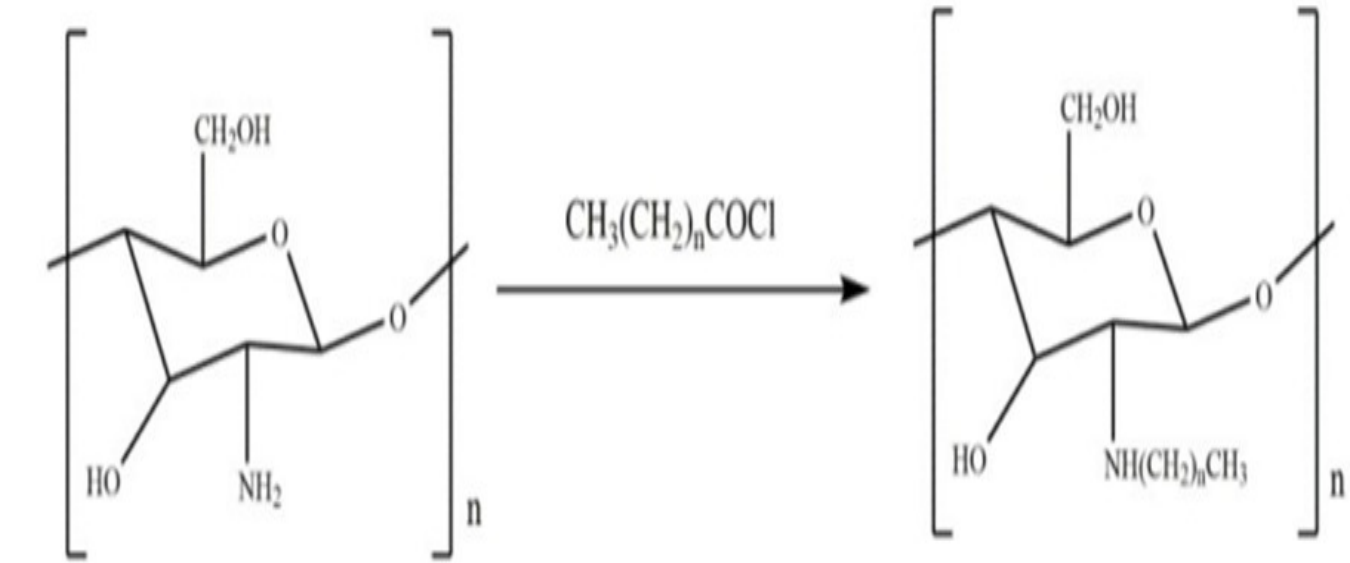
If only O-acylated chitosan is required, it is necessary to add a solvent to protect .the ammonium group, such as trifluoroacetic Acid

Acylated Modified Chitosan

O-acylated chitosan is lipid-soluble and can be dissolved in non-polar Solvents such as pyridine .and chloroform

Reaction equations for acylated chitosan .derivatives

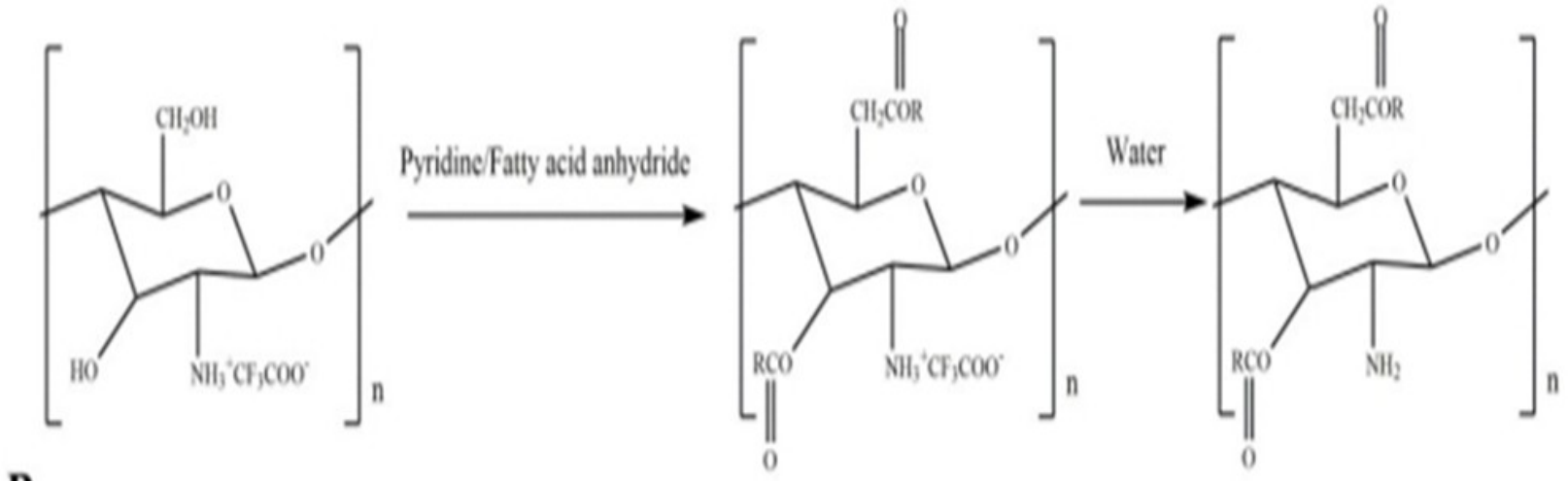
.N-acylated chitosan (A)



A

Acylated Modified Chitosan

O-Acylated (B)
.chitosan



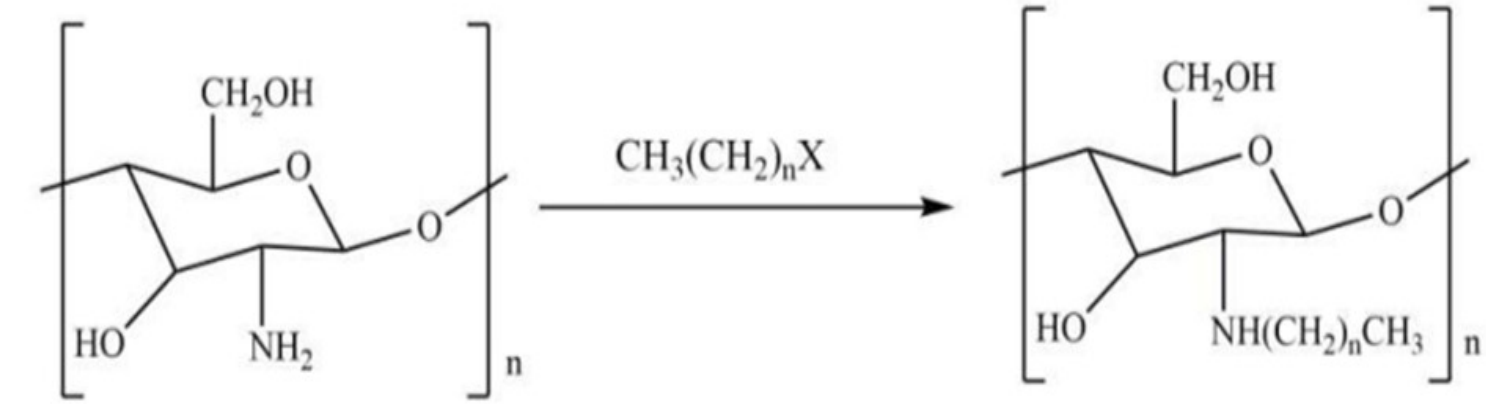
B

Alkylation Modified Chitosan

Alkylated chitosan can be used to prepare medical gauze due to its coagulation .and antibacterial Properties

Alkylation chitosan derivative .reaction equations

Halogenated alkane to (A) .prepare N-Alkylated chitosan



A

Carboxylated Chitosan

Carboxylated chitosan has wider Applications than chitosan in the .industry, agricultural, medical, health, and biochemical fields

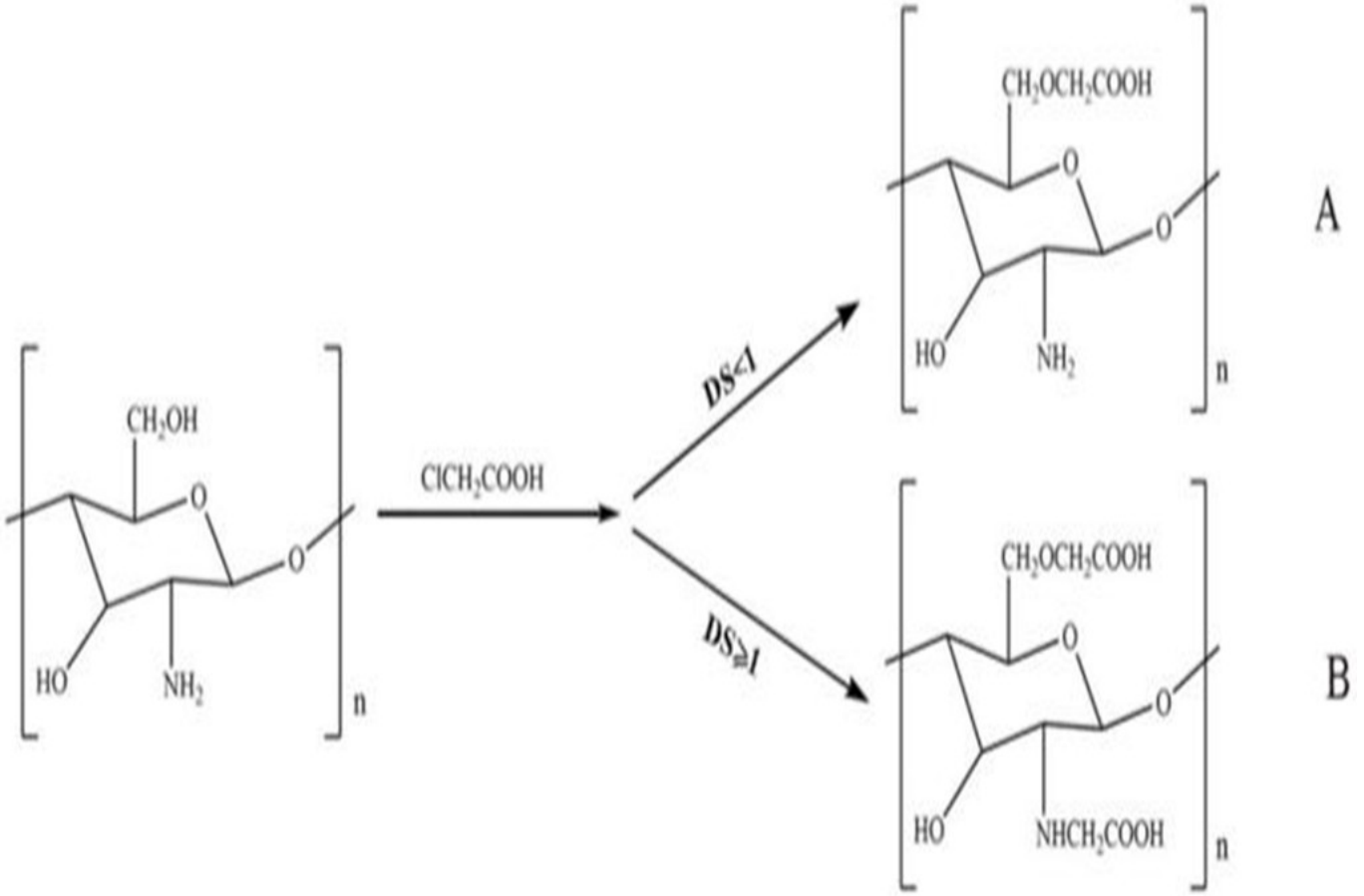
active in the biomedical and pharmaceutical fields due to its .antibacterial properties, which promote wound healing

Carboxylated Chitosan

Carboxylates chitosan derivative reaction equation.

(A) O-car boxy methyl chitosan (degree Of substitution (DS) < 1)

(B) N, O-car boxy methyl chitosan (DS ≥ 1).

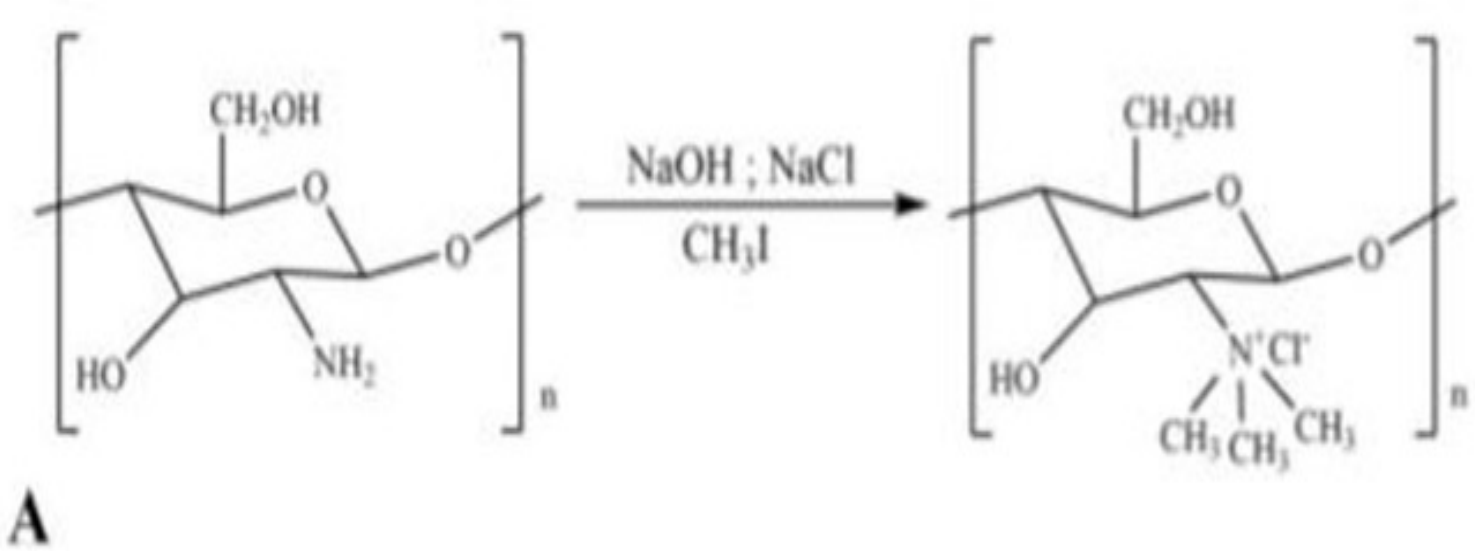


Quaternary Ammonium Chitosan

Quaternary ammonium chitosan salt also has better antibacterial, biodegradability, non-toxicity, and biological effects, and the .ability to penetrate mucus layers

Reaction equations for quaternized chitosan .derivatives

N,N-trimethyl chitosan ,(A) (TMC) direct quaternary



A

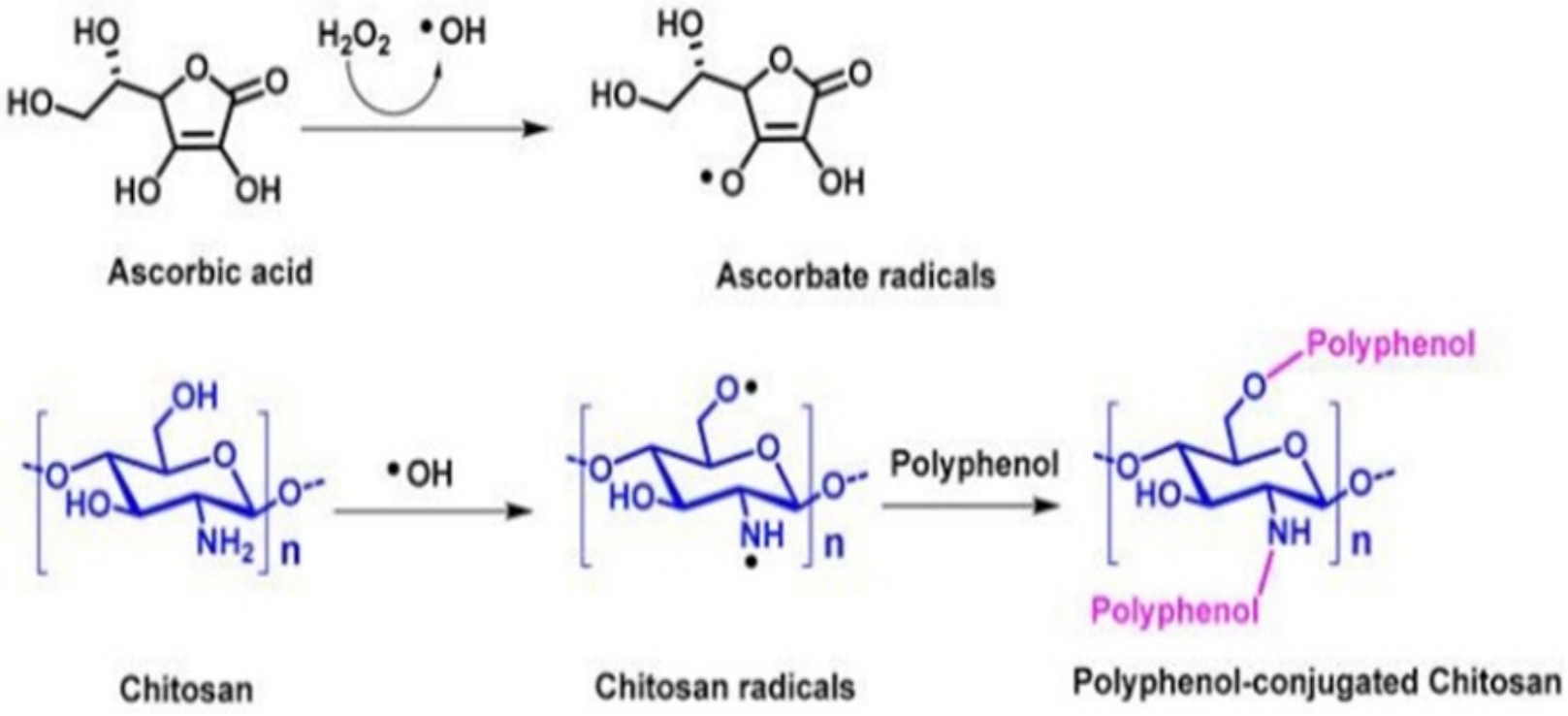
Chitosan-Polyphenol Conjugates for Human Health

- **Polyphenol limitations:**
  1. Low bioavailability
  2. Short biological shelf life
  3. Rapid metabolism in body.
- **Chitosan limitations:**
  1. Poor water insolubility
  2. Faster enzymatic degradation in body
  3. Non-availability of H atom donor
- **Chitosan –polyphenol conjugates advantages**
  1. Higher solubility
  2. Extended shelf life
  3. Increased bioavailability
  4. Higher antioxidant effect
  5. Synergistic anti-bacterial activity

Chitosan-Polyphenol Conjugates for Human Health

Proposed mechanism for polyphenol-chitosan conjugate through

free radical in Duced. reaction



Synthesis and characterization of new functionalized chitosan and its antimicrobial and in-vitro release behavior from topical gel

:Heterocyclic nitrogen-containing compounds

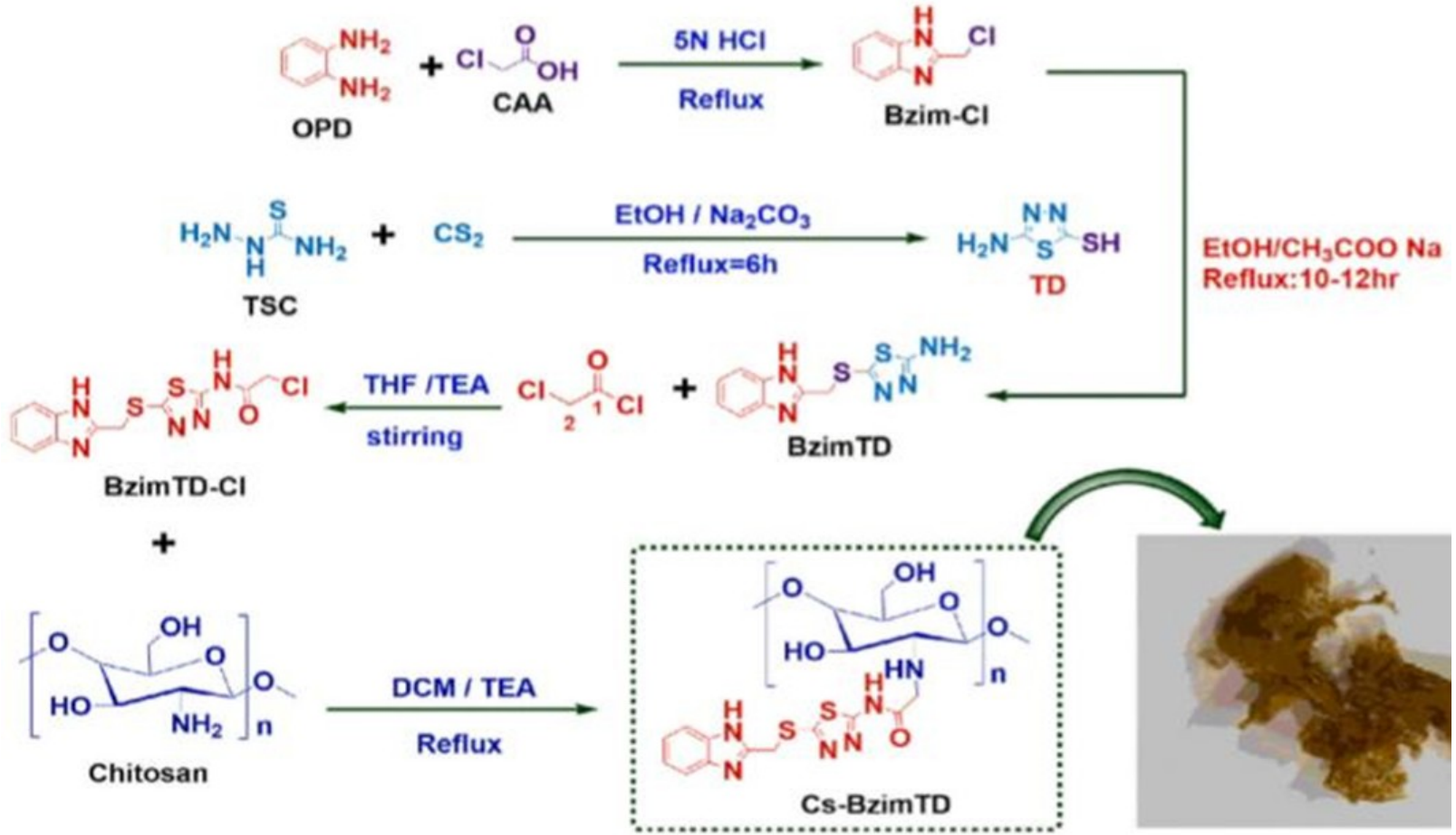
.(Including the five-membered Benzimidazole and thiadiazole moieties)

More than 75% of the drugs authorized by the Food and Drug administration and currently available in the pharmaceutical market .belong to this group of therapeutic compounds

benzimidazole is one of the most famous and biologically active Members of the heterocyclic group and is found in many synthetic and Natural .therapeutic agents such as: anticancer, antimicrobials, antioxidants

Synthesis and characterization of new functionalized chitosan and its antimicrobial and in-vitro release behavior from topical gel

OPD	**Ortho Phenyl Diamine**
CAA	**Choloro Acetic Acid**
TSC	**Thiosemi carbazide**
TD	**Thisol diamine**

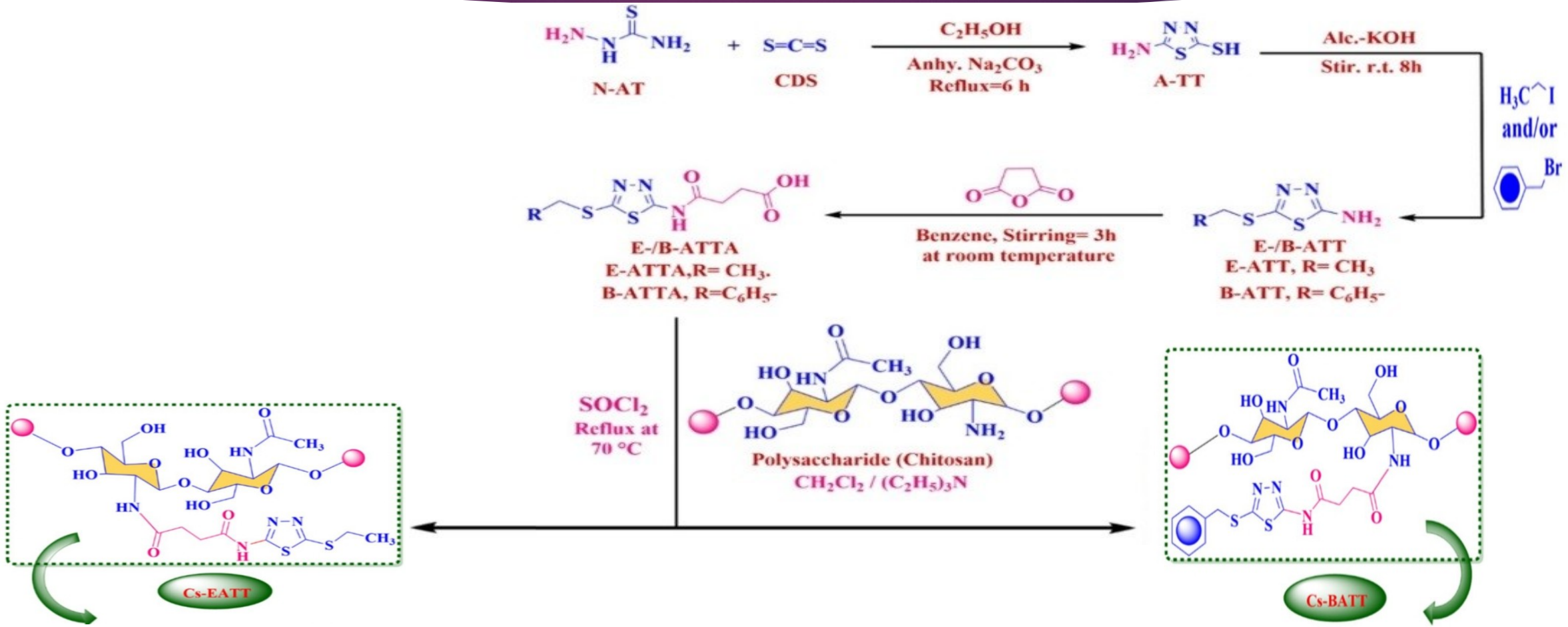


thiadiazole modified-1,3,4 chitosan

For example, two new polymers designated as Cs-EATT and Cs-BATT have been synthesized via linking the chitosan with the synthesized 1,3,4 .thiadiazole compounds

Synthetic diagrams of major reactions occurring during the syntheses of Chitosan derivatives

thiadiazole modified-1,3,4 chitosan



Natural Gum Based Composites Chemical Modification, Property Evaluation and Applications

The natural gums are non-toxic, biodegradable and low cost polysaccharide .they are applicable in various areas such as pharmaceuticals paints

Gum Arabic (GA) is one of the natural complex polysaccharides, derived .from an exudate of Acacia trees the other existing gums are guar gum

Guar gum (GG) is a non-ionic natural polysaccharide sourced from the seeds of cyamopsis, guar gum is used in many applications in industries such as, textile, petroleum, paper, food, explosives and it is non-toxic, low-cost and .amenable to chemical modification

Carboxy methyl guar gum was formulated as micro particles tailored for drug .delivery applications

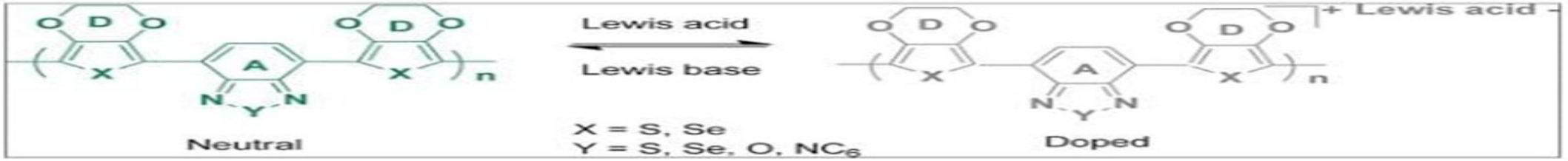
Conducting Polymers

.the delocalized electrons may move around the whole system

.However, conjugation is not enough to make the polymer material conductive

.In addition, the polymer material needs to be doped for electron flow to occur

Doping is either the addition of electrons (reduction reaction) or the removal of electrons : (oxidation reaction) from the polymer, for example



.As the electrons are moving along the molecule, electric current occurs

For better conductivity the molecules must be well ordered and closely packed to limit the .distance "jumped" by the electrons

Electrical Conductivity of Oxadiazole and Triazole Polymer Content

It was noticed that the electrical conductivity of organic Conjugated polymers was .increased when they are doped with oxidizing or reducing agents

By controlling the oxidation or reduction processes, the electrical conductivity and .optical properties of the polymer can be controlled

In this work different polymers with oxadiazole and triazole heterocyclic ring have been prepared to prove the effects of chemical structure on the electrical .conductivity

On the other hand, the ability to Doping was studied by different dopant The electrical conductivity of the conjugation polymers can be affected by different factors The Presence of long aliphatic segment within the back bone of the polymer chain can increased the electrical conductivity of the polymer by increasing the flexibility On the other hand the presence of aliphatic segment interrupts the conjugation and decrease the electrical conductivity The presence of the hetero atoms in the main chain of the polymer will enhance the electrical conductivity by the Participation of the lone pair of electron of the hetero atoms in the conjugation system

Conducting Polymers

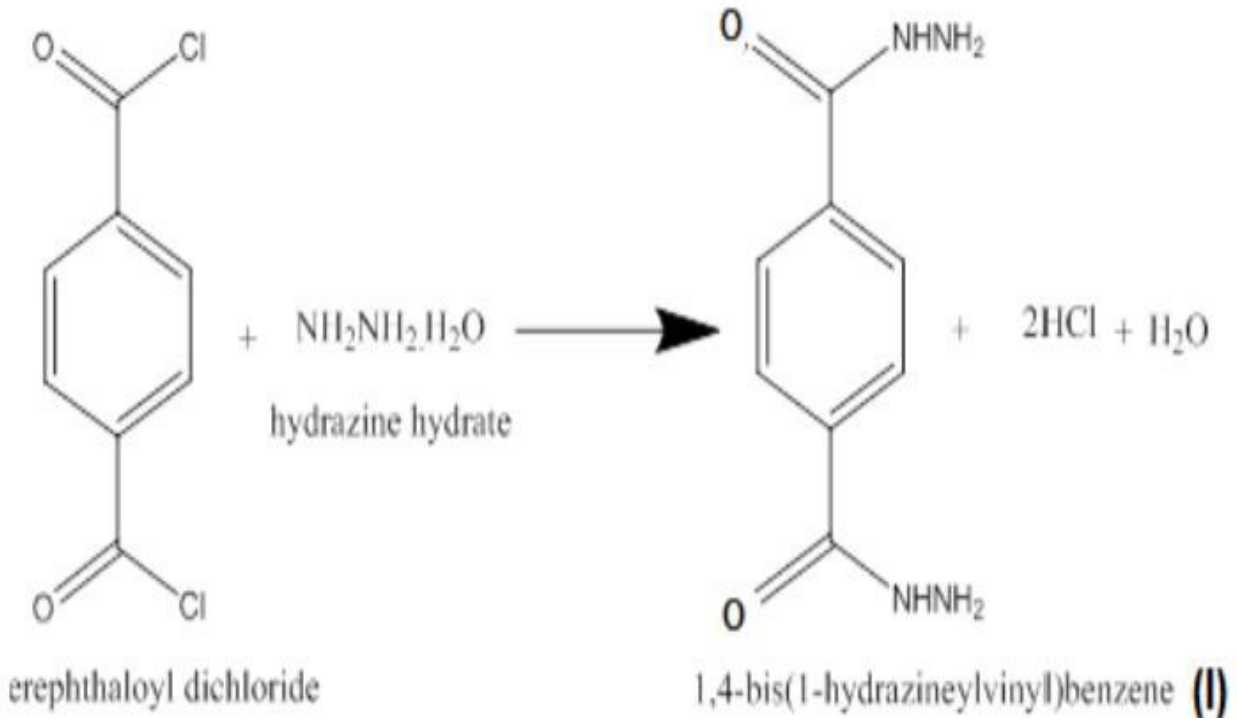
Synthesis of

:bis (1-hydrazineylvinyl)benzene (I)-1,4

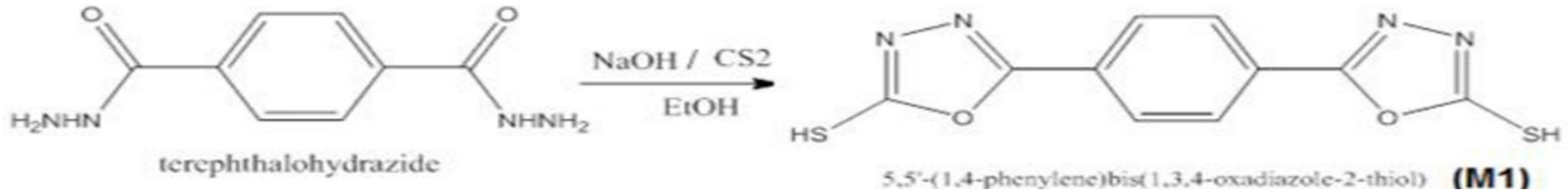
In a round bottom flask contain 20ml of hydrazine hydrate and 2ml dry dioxane, adding drop wise a solution of 6.5g (0.03mole) of terephthaloyl chloride dissolved in 6ml dry dioxane at room .temperature

.The mixture was refluxed for extra 2 hrs

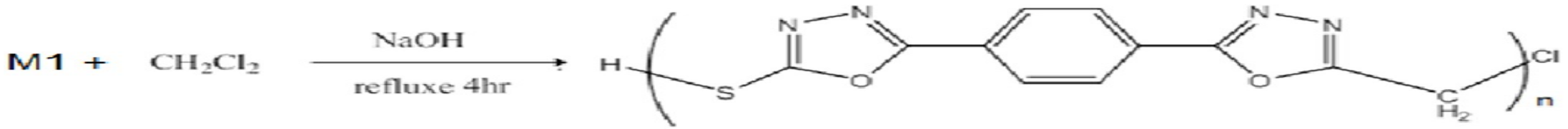
The yellow precipitate was filtered, washed with ethanol and dried under .vacuum



Conducting Polymers



Polymer preparations:
Polymer I: 1.43g (0.005mole)of M1 was dissolved in 0.1M NaOH solution.0.42ml of dichloromethane was added drop wise and the reaction mixture was refluxed for of 4hrs.



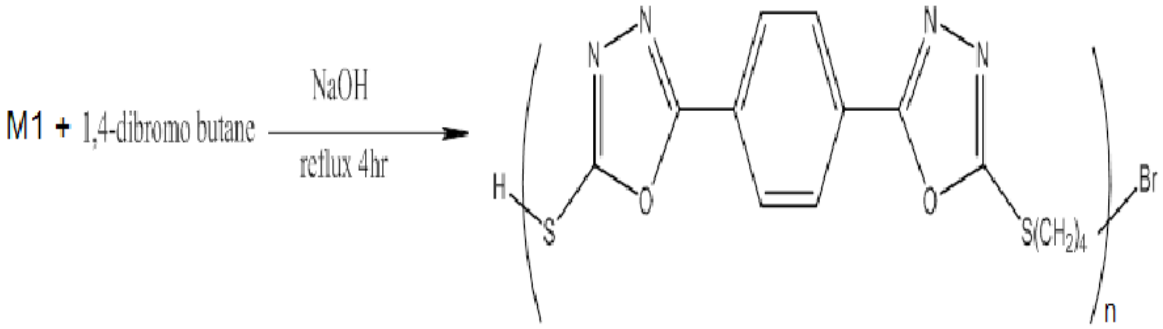
The produced yellow polymer was filtered and dried under vacuum.

Conducting Polymers

Polymer II: The same procedure for preparation polymer I was followed by polymerization of .M1with 1.07ml of dibromobutane

The results indicate that the major factor effect on conductivity is the .chemical structure of the polymer

It was noticed that the electrical conductivity of polymer III is higher than that of polymer I



Polymer III

polymer	σ S.Cm^{-1}
I	$3.8X10^{-8}$
II	$5.74x10^{-8}$
III	$4.4X10^{-8}$

Applications of conductive polymers

- polyaniline is used as a conductor
- Polyaniline is also manufactured as a corrosion inhibitor.
- Poly(ethylenedioxythiophene) (PEDOT) doped with polystyrene sulfonic acid is manufactured as an antistatic coating material
- Poly (dialkylfluorene) derivatives are used as the emissive layer in full-color video matrix displays.
- Poly (thiophene) derivatives are use in supermarket checkouts.
- Poly (pyrrole) as the active thin layer of various sensing devices.